CESA
CALIFORNIA ENERGY STORAGE ALLIANCE

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Final

Issue 23 Question

"Should the Commission consider issues related to the interconnection of electric vehicles and related charging infrastructure and devices and, if so, how?"

Introduction

To ensure progress toward greater Vehicle-to-grid (V2G) deployments, CESA believes that any potential interconnection issues should be proactively discussed and modified to accommodate a growing technology class. Providing an interconnection pathway for V2G systems will encourage greater deployment of electric vehicles (EVs) that can also support the grid and may reduce the grid upgrade costs that may ultimately be borne by ratepayers and EV owners. Interconnections of V2G DC systems – in which an inverter is incorporated into the EV supply equipment (EVSE) and not onboard the vehicle – are currently possible and the consideration of V2G interconnections is not 'exotic' but something that is commercially viable today. It is important to note the guidance from R.13-11-007 that sought to reduce barriers for electrified vehicles acting as storage devices.[1] While there are other barriers to address as well (*e.g.*, sub-metering, dual DR program participation), interconnection presents one of the potential major barriers that could hinder this valuable use case. Since the focus of this working group is on addressing Rule 21 interconnection issues, CESA only lists the other issues and barriers as context for the background and current state of V2G resources, which are currently commercially viable but are working through barriers and key policy developments at each of the state's key energy agencies.

CESA notes that the customer experience should be an important factor that should be taken into account in not only the Vehicle-Grid Integration (VGI) Roadmap Update but also in these Rule 21 working group discussions. A streamlined interconnection process that does not take unnecessarily large amounts of time and costs (*e.g.*, upgrades, interconnection fees) is needed to ensure that EV deployments do not come at the expense of interconnection study processes. For similar reasons, site-by-site review of interconnection requests may pose challenges to the widespread viability of V2G. CESA urges the CPUC, IOUs, and other stakeholders to keep in mind the customer experience in developing V2G interconnection pathways; otherwise, V2G will never take off in California.

Finally, one of the key goals in addressing this issue is to provide automotive OEMs and EVSE providers with the regulatory signal that applicable V2G systems have a clear path to interconnection, thus providing them with the market certainty to proceed with commercial development and rollout of V2G-capable vehicles. Otherwise, with a murky or unviable path to interconnect to the grid, automotive OEMs and EVSE providers will opt to forgo the development of V2G-capable systems in their EVs and EVSEs given the added development costs and risks.

[1] See Section 3.8: Conforming Rule 21 to accommodate SAE standards.

Background

The CAISO, CPUC, and CEC jointly published the VGI Roadmap in 2014 and the CPUC opened an Alternative Fuel Vehicles (AFV) rulemaking (R.13-11-007) to be kickstarted to define the VGI use cases and define the barriers and activities needed to achieve the vision of the roadmap.[2] Since then, significant efforts have been undertaken to increase investments toward EVs and EVSE deployment and to develop time-of-use (TOU) rates to encourage optimal charging. The potential for EVs and EVSEs to be activated for grid benefit has been recognized most recently in California's system-wide modeling efforts in the Integrated Resource Plan (IRP) proceeding (R.16-02-007), which found that "flexible EV charging" could reduce the amount of renewable generation and energy storage selected to meet the 2030 GHG planning targets.[3] The focus to date has been on the potential to mobilize the one-way managed or "smart" charging (V1G) capabilities of EVSEs. While valuable to manage customer bills and provide load response, the range of grid services that could be provided may leave some value left on the table if only the "load side" capabilities are leveraged for EVs and EVSEs. At higher levels of EV penetration, there may be instances where bidirectional EV capabilities provide valuable customer and grid services.

V2G technologies represent an opportunity to take advantage of the fast-responding 'storage-like' systems integrated in EVs, plug-in hybrid electric vehicles (PHEVs), and EVSEs to serve onsite customer load, provide grid services, and support true vehicle-grid integration. V2G is defined in many ways and is often cited as encompassing technologies that have the capability to be controllable and communicate with the power grid, including for demand response services. For the purposes of this paper, CESA focuses the definition of V2G on bi-directional electrical energy flow between the EV/EVSE and the grid.

Studies have shown that V2G has the bidirectional capability to provide load shifting, regulation services, and operating reserves.[4] The added capability of V2G to export energy from the EV battery to onsite load or to the grid presents new opportunities to manage onsite loads and customer bills, provide whole-load demand response, provide needed energy onto the grid for other customers during peak demand hours, and provide both regulation up and regulation down services. With additional sources of revenue from participating in the energy and ancillary services markets at the CAISO, or by providing other distribution grid services to the utility (*e.g.*, distribution deferral, voltage support), V2G could improve the cost-effectiveness of EVs and thus accelerate the adoption of EVs and PHEVs, especially when targeting customers with EVs with long dwell times (*i.e.*, available for many hours with a full charge, predictable loads).

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[2] *California Vehicle-Grid Integration (VGI) Roadmap: Enabling vehicle-based grid services*, published in February 2014. http://www.caiso.com/documents/vehicle-gridintegrationroadmap.pdf

[3] *Attachment A: Proposed Reference System Plan*, published on September 18, 2017, p. 139. http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M195/K910/195910807.PDF

[4] Steward, Darlene. *Critical Elements of Vehicle-to-Grid Economics*, National Renewable Energy Laboratory, published in September 2017. https://www.nrel.gov/docs/fy17osti/69017.pdf

V2G systems may fall into two categories: (1) those that utilize bidirectional inverters within the EVSE ("V2G DC");[5] and (2) those that utilize bidirectional onboard inverters within the EV ("V2G AC").

Currently, there are a number of pilots taking place in the country that aim to demonstrate the viability of V2G use cases. The first V2G system demonstration was launched by the University of Delaware (UDel) and NRG in collaboration with automotive OEMs, Honda and BMW. In California, automotive OEMs, Honda and Nissan, are working with Nuuve, a software aggregator, in the Electric Vehicle Storage Accelerator (EVSA) to test different use cases of V2G technologies at the University of California, San Diego (UCSD) campus. Specific use cases being tested include wholesale market participation and backup power. At the LA Air Force Base (LAAFB), Southern California Edison (SCE) worked with Nissan, Princeton Power, Kisensum, and Lawrence Berkeley National Laboratory (LBNL) to demonstrate V2G capabilities to bid energy and ancillary services directly into the CAISO's wholesale markets and to evaluate the revenue potential of having V2G resources participate as demand response.[6] [7]

Significant progress is being made in each of these pilots and the technology is maturing to the degree that V2G systems are commercially viable and capable of providing grid services reliably and safely. But at the moment, there are several existing issues and barriers that limit the market opportunities for V2G systems, which CESA has highlighted in our comments to the VGI Roadmap Update on November 21, 2018.[8] Consideration is needed to improve programs, tariffs, and market participation pathways to better value smart dispatch and export capabilities of EV-related assets (*e.g.*, barriers to the Non-Generator Resource [NGR] model and capacity valuation for BTM aggregations, eligibility of the Proxy Demand Resource [PDR] model to BTM storage), as well as to unlock their multiple-use application (MUA) potential (*e.g.*, current dual demand response [DR] participation prohibitions). CESA recognizes that other potential issues are currently being worked to be resolved, such as: vehicle battery warranty concerns, vehicle technological capabilities, metering and telemetry requirements, comprehensive control algorithms, and contractual requirements that would provide sufficient value to all parties.

Importantly, consideration is also needed in how V2G resources and aggregations of V2G systems can be enabled by reducing potential barriers to their deployment. The aforementioned pilots have encountered interconnection issues that have represented a barrier to implementation of new use

[5] The first bidirectional DC EVSE received Permission to Operate (PTO) from at LA Air Force Base. The next one was in SDG&E territory on April 24, 2018.
[6] *Southern California Edison Company's Department of Defense Vehicle-to-Grid Final Report*, submitted on December 22, 2017. www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442455793
[7] Black, Douglas, *et al*., Lawrence Berkeley National Laboratory. 2017. *Los Angeles Air Force Base Vehicle-to-Grid Demonstration*. California Energy Commission. Publication Number: CEC-500-2018-025. https://www.energy.ca.gov/2018publications/CEC-500-2018-025/CEC-500-2018-025.pdf
[8] See CESA's comments on the VGI Roadmap Workshops.

cases. V2G systems have Rule 21 interconnection implications in specific use cases, which are discussed further below. In addition to considering how individual V2G units are studied in Rule 21 processes, this working group should also discuss how the Rule 21 processes can support aggregations of V2G units, which will be coordinated to provide any given grid service, such as through the Distributed Energy Resource Provider (DERP) model. By subjecting each BTM unit to interconnection processes, it may slow down the deployment of and raise costs for such V2G assets to the degree that these opportunities may not be pursued.

Potential Scope

EV batteries and EVSEs are generally assumed to be end-use loads that are connected to the grid as additional load through service connections, and thus are not subject to Rule 21 interconnection review. CESA emphasizes that modulated and smart charging (V1G) should not be subject to Rule 21 interconnection, and should maintain service connection as a means to connect this end-use load to the distribution grid. Like other demand response and grid-responsive loads, Rule 21 interconnection review is not applicable to and should not be required for V1G, or EVs and EVSEs in general that do not participate in V2G programs.

Electrified vehicles or EVSEs with V1G capabilities can deliver wholesale and distribution grid services by modulating the power draw from the grid in response to a given schedule or a signal: V1G systems may respond to retail EV or TOU rates, be economically dispatched in the CAISO markets through the Proxy Demand Resource (PDR) model, or be directly dispatched for reliability services (*e.g.*, to provide distribution deferral). In each of these cases, the EVSE and EV batteries act as demand response similar to other grid-responsive loads, such as air-conditioning units and smart thermostats, which do not require Rule 21 interconnection review. This is made clear in Section B.1 of the Rule 21 tariff where interconnection only applies to generating facilities, which do not encompass load-side facilities:

> *"This Rule describes the Interconnection, operating and Metering requirements for those Generating Facilities to be connected to Distribution Provider's Distribution System and Transmission System over which the California Public Utilities Commission (Commission) has jurisdiction."* [emphasis added]

However, V2G systems differ from V1G systems in that the EVSE or EV battery can be discharged to serve customer load and/or provide grid services by either: (1) providing demand response by acting like a behind-the-meter (BTM), non-export energy storage system ("V2G Non-Export"); or (2) providing bi-directional capabilities (*i.e.*, including exports across the point of common coupling [PCC]) similar to a BTM exporting energy storage system ("V2G Export"). Since bidirectional inverters can be integrated in either the EVSE or EV, further distinction needs to be made for all the use cases. Rule 21 jurisdiction applies to V2G systems in either use case as they now function as a generating facility (see Section B.1 below):

> *"This Rule describes the Interconnection, operating and Metering requirements for those Generating Facilities to be connected to Distribution Provider's Distribution System and Transmission System over which the California Public Utilities Commission (Commission) has jurisdiction. All Generating Facilities seeking Interconnection with Distribution Provider's Transmission System shall apply to the California Independent System*

Operator (CAISO) for Interconnection and be subject to CAISO Tariff except for 1) Net Energy Metering Generating Facilities and 2) Generating Facilities that do not export to the grid or sell any exports sent to the grid (Non-Export Generating Facilities). NEM Generating Facilities and Non-Export Generating Facilities subject to Commission jurisdiction shall interconnect under this Rule regardless of whether they interconnect to Distribution Provider's Distribution or Transmission System. Subject to the requirements of this Rule, Distribution Provider will allow the Interconnection of Generating Facilities with its Distribution or Transmission System." [emphasis added]

Use Case	Does Rule 21 apply?	Details
Basic EV Charging Load	No	Some EV owners do not engage in smart charging programs and may simply voluntarily respond to whatever rate they take service under.
V1G EVSE + EV	No	V1G systems are strictly load and are subject to Rules 15/16, which reviews load thresholds to trigger distribution upgrades but otherwise are service connections without study processes.[9] They should not be subject to generator studies under Rule 21, similar to traditional DR services, even as load-responsive services can be provided.
V2G Non-Export EVSE ("V2G DC")	Yes	In this case, the EVSE is integrated with a bi-directional inverter and the DC EV battery serves as the load and generator 'source', similar to most BTM energy storage systems. The "Non-Export Generating Facilities" provisions within Rule 21 should apply, with some potential modifications. Similarly, the load-side study may involve Rules 2, 3, 15, and 16.
V2G Non-Export EV ("V2G AC")	Yes	In this case, the EV is integrated with an onboard bi-directional inverter alongside the EV battery, serving as the load and generator 'source', similar to BTM energy storage with integrated inverters within the same module. The "Non-Export Generating Facilities" provisions within Rule 21 should apply, with some potential modifications if these functions are utilized or enabled. Similarly, the load-side study may involve Rules 2, 3, 15, and 16.
V2G Export EVSE ("V2G DC")	Depends	WDAT may apply when exporting to the CAISO grid, while Rule 21 may apply when exporting and selling to the distribution utility.
V2G Export EV ("V2G AC")	Depends	WDAT may apply when exporting to the CAISO grid, while Rule 21 may apply when exporting and selling to the distribution utility.

For all V2G use cases, Rule 21 interconnection review may be required to support the interconnection of any "generating facility" and utility-interactive inverter, but the current Electric Rule 21 does not include

[9] CESA recognizes that the exemption to Rule 15 and Rule 16 may not be renewed past its current expiration date of June 30, 2019.

interconnection considerations for inverters for mobile energy resources. Interconnection of V2G systems have been done on a case-by-case basis to date[10] but modifications to Rule 21 are necessary to set a standardized interconnection review process. For all V2G Non-Export use cases, only a load-side study may be needed similar to what is applied for non-exporting BTM energy storage systems, with expedited or 'cursory' Rule 21 review to ensure no coincident peak-time charging impacts, verify no exports from the metered connection, and review fault current contribution. For certain V2G Export use cases, Rule 21 interconnection review would be needed, or the Wholesale Distribution Access Tariff (WDAT) would likely apply if the system is exporting to the CAISO grid (*e.g.*, to participate as a Non-Generator Resource [NGR]). A question here may be whether modifications to the WDAT to accommodate V2G systems is within the scope of this working group. It will be important to consider customer experience in each of these scenarios.

For all V2G use cases, this working group will need to consider the applicable codes and standards as well. IEEE 1547 is highlighted in Section B.3 as being "harmonized" with Rule 21 and a new Section Hh on smart inverter certification and requirements has been added to Rule 21 to incorporate the UL 1741 – Supplemental SA standard for all inverter-based generation. For bidirectional mobile (onboard) inverters used in V2G AC applications, the Society of Automotive Engineers (SAE) standards have been developed to harmonize with IEEE 1547, so there should be a focus in this working group on how much SAE standards align with (and/or have gaps compared to) IEEE 1547 and UL 1741.

For all V2G use cases using a fleet approach, this working group will also need to discuss how sub-metered EVs and EVSEs can address Rule 21 technical requirements in aggregate at the customer meter without having to interconnect each EVSE individually. Once an interconnection pathway for applicable individual EVs and EVSEs is clarified and defined, the next step will be for the CPUC, IOUs, and stakeholders to work together on how enabling fleet-level interconnections.

Proposal Concepts

The core objective of CESA's proposals is to adopt a streamlined Rule 21 interconnection process that enables the widespread commercial adoption of V2G systems. Having undergone several pilots, V2G systems are now ready for broader commercial adoption, and interconnection studies and processes should not pose a barrier to deploying V2G systems. In the two weeks that have been allocated to Issue #23, CESA finds it not to be enough time to address the interconnection issues involved for V2G Non-Export EV and V2G Export EV use cases (*i.e.*, V2G AC interconnections in which the inverter is onboard the vehicle), and thus focuses its proposal concepts around V2G Non-Export EVSE and V2G Export EVSE use cases (*i.e.*, V2G DC interconnections in which the inverter is stationary within the EVSE). This should only require minor language changes to the Rule 21 tariff and interconnection portal to authorize these interconnections. Instead, CESA proposes that V2G AC interconnection issues for EVs with onboard mobile inverters should be teed up in a future working group (*e.g.*, Working Group 4) or sub-group in this proceeding (R.17-07-007) where additional significant time can be dedicated to addressing concerns from the IOUs as well as to make the appropriate modifications to Rule 21 processes, engineering review studies, linkages to applicable standards, and modifications to interconnection tariffs and portals.

1. **Establish applicability of Rule 21 only when bi-directional capabilities are activated and utilized**

[10] A municipal utility in Delaware is a precedent for consideration in this working group.

CESA recommends that CPUC programs and the Rule 21 tariff clarify when Rule 21 interconnection processes apply, and when they do not. As noted above, Rule 21 interconnection should not apply to V1G systems – *i.e.*, uni-directional charging EVSEs and EVs with no onboard inverters used as a generating facility. Electric Rules 15 and 16 apply in these cases, where such EVSEs and EVs are considered end-use load and require service connections but not interconnection studies. Similarly, Rule 21 should not apply to bi-directional EVSEs and EVs with onboard inverters if these bi-directional capabilities are not activated and utilized. In doing so, V2G-capable systems will still provide customers with a streamlined deployment experience while allowing for further Rule 21 interconnection study as needed to activate V2G functions. In the same vein, CPUC programs should also not require V2G capabilities, but instead should allow for customers to opt-in to these capabilities. CESA cautions against requiring every customer to go through an interconnection process if they do not plan to engage in V2G activities.

2. Authorize V2G DC interconnections and make the appropriate modifications to the Rule 21 tariff and portal

CESA recommends that V2G-capable EVSEs (V2G DC) be authorized for Rule 21 interconnections.

Interconnection Applicant and Point of Interconnection

In the case of V2G-capable EVSEs, it is unclear who would be the interconnection applicant that ultimately signs and executes the interconnection agreement with the distribution utility. Is it the EVSE provider or the individual EV customers? For BTM energy storage systems, the interconnection applicant is generally the project developer and owner that interconnects units behind the same customer meter. The interconnection applicant may depend on the use case but the point of interconnection (POI) where all interconnection studies should be done should be at the PCC in both of the following cases:

- **Single V2G EVSE customer:** In this case, the interconnection applicant will likely be the host customer or the developer for the single host customer. An individual EVSE interconnection would thus be required. Interconnection studies should be conducted at the PCC.
- **V2G EVSE fleet customer:** For fleet operators, the interconnection applicant should be the aggregator of the fleet, with the EVSE provider serving as the 'gatekeeper' for all interconnection-related operational and control requirements. The EVSE would manage charging and discharging from the EVSE and modulate EV battery load.[11] Interconnection studies should be conducted at the PCC.

In general, CESA believes there are many paths forward. In some cases, the EVSE may act as the gatekeeper for V2G capabilities, whereas in other cases, the EV may communicate directly with the third-party aggregator that talks to the IOU (in which case the signal for grid services does not come from the EVSE). In some ways, there may be some advantages to the EVSE acting as

[11] Coordination with the transportation electrification proceedings and VGI working groups is needed to certify any communications between EV and EVSE. This is not within the scope of Rule 21.

the gatekeeper since there will not need to be a certification or re-certification process for each and every EV model that could potentially charge or discharge at the EVSE and/or undergo an associated software update.

Interconnection Portal

Even as V2G-capable EVSEs can be viewed and studied similarly to BTM energy storage systems, CESA observes that there are barriers to initiate the interconnection application, with some early applications taking up to one year to be deemed complete and valid. To address these preliminary barriers to even get a study process initiated, CESA believes that changes must be made to the interconnection portal. For example, in supplemental documents, the IOUs require that generating facilities show the generator location and the POI. In the case of V2G EVSEs, it is reasonable to designate the EVSE as the generator with the POI being at the PCC.[12]

CESA understands that more detailed discussion on specific portal enhancements can be done through Issue #22 in Working Group 3 ("Should the Commission require the Utilities to make improvements to their interconnection application portals? If yes, what should those improvements be?"), in which CESA will make more specific improvement suggestions. With specific accommodations on EVSEs in the application and the portal, there will be a standardized format by which V2G EVSEs are classified, categorized, and studied, which will streamline the front-end of the interconnection process.

Streamlined Study Processes

As noted in our previous section on applicability, Rule 15 and 16 should apply for load-side review of EVSE service connections. Until the interconnection applicant initiates a Rule 21 study process by submitting an application, no interconnection requirement should be set, even as EVSEs (and associated EVs using the charger) may be V2G capable.[13] To activate V2G capabilities, a Rule 21 process would be needed and the interconnection applicant would then submit an interconnection application to initiate a Rule 21 process to allow EVSEs to discharge from the EV to the grid. Similar to BTM non-exporting storage systems with Rules 2 and 3, a transfer process from the load-side review may be needed for EV and EVSE systems subject to Rules 15 and 16 processes.

For V2G Non-Export EVSE use cases, CESA raises the possibility of considering how Rule 21 interconnection review processes could be adapted from the recently approved one-year pilot for expedited interconnection review of non-export, standalone energy storage systems that meet specific eligibility criteria[14] (with CESA's comments in highlighted in ***red italicized font***):

[12] As discussed above, in the case of V2G DC interconnections, further modifications will be needed to account for a mobile EV as the generator.

[13] To illustrate, CESA notes that Nissan LEAFs sold after 2013 were bi-directional capable, but since they were not prohibited from discharging via software controls, they did not pose grid reliability or safety risks. While the IOUs were unaware of these capabilities, it thus highlights how it is reasonable and safe to allow for V2G-capable systems to connect to the grid so long as these capabilities are not activated and do not discharge to the grid or to customer load.

[14] Rule 21 Section N.

- Cannot exceed 0.5 MW in aggregate inverter and/or rectifier nameplate rating (but any energy storage kWh rating may apply) – ***A similar threshold could be set. CESA does not see any reason why this threshold should be differentiated for stationary BTM energy storage versus stationary V2G EVSEs that have similar capabilities but with the 'storage reservoir' located in the EV batteries rather than integrated in the same 'box' where storage controls are located. Similarly, the load studies should focus on the inverter rating of the EVSE as opposed to the EV battery capacity and should allow for any kWh rating to apply.***
- Must be behind a single, clearly marked, and accessible disconnect – ***No changes are needed. The disconnect can be located and managed at the EVSE. This appears to already be mandatory for Level 2 EVSEs.***[15]
- Only Screen I Protection Options 3 and 4 are eligible, as well as potentially AC/DC converters pending their lab results – ***No changes are needed.***
- Must be at a single retail meter point of interconnection – ***No changes are needed.***
- Must have a single or coordinated control system for charging functions – ***No changes are needed.***
- Must operate under "Charging Mode 2" wherein charging functions do not increase the host facility's existing peak load demand – ***This criterion must be viewed within the context of EV charging load increasing customer peak demand in certain applications, and of some EVSEs taking service under separate rates from the host customer load.***[16] ***CESA is open to discussion on whether this criterion would need to be adjusted for V2G EVSEs.***
- Must have a UL-1741 certified inverter – ***No changes are needed at this time for V2G DC systems.***
- Must include a single-line diagram and description of operations – ***No changes are needed.***
- Must meet all Electric Service Requirements – ***No changes are needed.***

For projects meeting the above criteria and submitting all the relevant documentation, no distribution or network upgrades are required. Interconnection requests will be processed within 15 business days from the date the applicant's request is deemed valid and application fees are received. The IOUs recently filed advice letters on September 1, 2018 reporting on outcomes of this pilot process. Even as early readings of the advice letters indicate that the IOUs do not wish to move forward with this type of technology-specific interconnection review process, CESA believes that it may be worthwhile to consider how this process, perhaps adapted in some way to V2G use cases, could establish a performance-based interconnection review process.

For V2G Export EV or V2G Export EVSE use cases, CESA recommends the creation of expedited interconnection processes similar to what has been established for Net Energy Metering (NEM) generating facilities. Currently, NEM generating facilities under 1 MW are processed in 30 days or less after submitting a completed interconnection application,[17] and are eligible for fast-track

[15] See PG&E's code at https://www.pge.com/includes/docs/pdfs/about/environment/pge/electricvehicles/ev5pt3.pdf

[16] CESA notes that other jurisdictions, such as District of Columbia, are dealing with the challenge of distinguishing between electricity as a fuel versus electricity as a service.

[17] Rule 21 Section D.13.b.

evaluation when sized no larger than 3 MW on a 12 kV, 16 kV, or 33 kV lines.[18] As a policy decision, it may be reasonable to assess whether size thresholds could be established such that expedited fast-track processes or certain screen bypassing can be extended to V2G DC systems to facilitate the interconnection of V2G EVSEs that support the state's VGI objectives and provide additional grid services. For example, specific provisions for NEM generating facilities is granted under Screen K for NEM facilities below a certain size threshold (500 kW). This is a policy decision that should be considered by the CPUC.

3. **Direct a sub-group within Working Group #4 in this proceeding (R.17-07-007) to more deeply address V2G AC interconnection issues and to consider SAE J3072 applicability or changes needed to meet smart inverter requirements**

CESA does not believe the two meetings and few weeks dedicated to Issue #23 is sufficient time to comprehensively and effectively address Rule 21 interconnection issues for AC V2G systems with mobile onboard inverters. There are a number of technical details that need to be discussed between IOUs and other stakeholders to understand the concerns, address gaps, and propose the appropriate changes. Given the short amount of time, it is reasonable to at least authorize the Rule 21 interconnection of V2G EVSEs, which resemble BTM energy storage systems, but require a few modifications to the tariff and the portal.

CESA understands that a new proceeding (R.18-12-006) has been opened to address a range of issues related to vehicle electrification rates, infrastructure, and VGI issues. While this issue could be scoped there, CESA believes that R.18-12-006 is already overloaded with a wide range of issues and instead recommends that the Rule 21 proceeding is the appropriate forum to discuss these matters, which require the involvement of IOU interconnection engineers and specific tariff rule changes. CESA believes that Working Group #4 is the appropriate time and place to address these matters more deeply, perhaps done through the formation of a sub-group and with at least a few months allocated to focus on these complex and technical issues. The sub-group could even be formed prior to the Working Group #4 launch to allow the actual working group process to work through more fully-formulated ideas and proposals. In sum, CESA believes that more time is needed on AC V2G interconnection issues.

With more time dedicated to V2G AC interconnection issues, some of the questions that could be scoped in those discussions include:

- How will the IOUs be assured that site-specific settings will remain the same for all vehicles charging at the EVSE? Does the use of SAE J3072 requirements upon the EV and EVSE address these concerns?
- How will the IOUs be assured of how many V2G systems (*e.g.*, EV and EVSE pairings) will be available at specific times and specific locations? What is the role of third parties to forecast and provide dispatchable capacities for predetermined use cases?
- Since export to the grid may be site- and time-specific, how will the EV, in combination with V2G-capable EVSE as a 'gatekeeper', know where and when it can provide bidirectional capabilities, exports, etc.?
- What types of changes to interconnection queue management are needed to accommodate large volumes of V2G systems looking to interconnect?

[18] Rule 21 Section E.2.b.i.

- Are any changes needed to the material modification process for adding new V2G systems behind the same meter as existing, interconnected DER systems?

A key development in Rule 21 has been the incorporation of smart inverter requirements, pursuant to D.14-12-035 (Phase 1 autonomous inverter functions), Resolution E-4920 (reactive power priority setting), Resolution E-4832 (Phase 2 communication standards), and Resolution E-4898 (Phase 3 advanced inverter capabilities). Some of these requirements are already in place, such as the Phase 1 requirements, which have been mandatory as of September 8, 2017 for all inverter-based generation under Rule 21, that was approved to utilize UL 1741-SA.[19]

While UL 1741 is the testing standard that applies more reasonably to stationary inverters, this standard would make the automobile components unreasonably big and heavy. It has not been written with the intention to apply to onboard vehicle inverters, whereas SAE J3072 is the applicable standard for mobile inverters. UL 1741 requires certain equipment (*e.g.*, switches, relays) in the same inverter enclosure that may reduce the effectiveness of the EV to serve off-grid functions for the customer.

This is where the problem lies, as Rule 21 cites UL 1741-SA standards to demonstrate compliance with inverter safety, function, and requirements to interconnect to the distribution grid but does not cite SAE J3072. A strict interpretation of Rule 21 would thus prevent V2G AC use cases from interconnecting to the distribution grid because it does not meet UL 1741-SA standards, even as both UL 1741-SA [20] and SAE J3072 [21] both have references to IEEE 1547 to ensure safe interconnection and have the same safety testing and performance standards. Demonstration sites at UC San Diego have also shown that these systems can be interconnected safely and reliably.

CESA explains further in Appendix A its understanding of SAE J3072. CESA does not recommend adoption of SAE J3072 at this time, as it still requires further vetting and modifications to address any gaps between the SAE standard with UL 1741. With forthcoming updates to IEEE 1547 along with subsequent updates to UL 1741 citing IEEE 1547, there may need to also be an update to SAE J3072. The key question for this new sub-group to address is:

- Can the definition of "smart inverter" be broadened to not be limited to a 'box' but allow smart inverter functionalities, including communication capabilities, encompass the combination of the EVSE and EV?
    - For example, for the Phase 2 requirements, the EVSE may relay communication signals from the IOUs to the mobile inverter, while the EV's onboard inverter responds to those signals to provide the various Phase 1 and 3 functions.

[19] CESA understands that IEEE 1547.1 will be published soon.
[20] UL 1741 Section 40.1: "A utility-interactive inverter or interconnection system equipment (ISE) shall comply with the Standard for Interconnecting Distributed Resources with Electric Power Systems, *IEEE 1547*, and the Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems, *IEEE 1547.1*, excluding the requirements for Interconnection Installation Evaluation, Commissioning Tests, and Periodic Interconnection Tests." [emphasis added]
[21] SAE J3072 Section 4.8: "The inverter system shall meet the requirements of *IEEE 1547-2003* and Amendment 1 (January 2014) except as modified by Table 4." [emphasis added]

  - This is similar to how V2G DC systems have the storage medium (*i.e.*, EV batteries) located separate from the inverter (*i.e.*, within the EVSE), which is unlike traditional rooftop PV and BTM energy storage where these components are all housed within the same enclosure.
- Are there specific modifications needed in SAE J3072 to address interconnection (and smart inverter) concerns for certain V2G use cases?
  - SAE J3072 is designed to provide automotive OEMs with the flexibility to design and engineer their EVs to provide smart inverter functionalities, which is achieved by allowing the EVSE and EV to operate as a single integrated DER, which, in CESA's view, may provide the required functions of "smart inverters" within Rule 21.
- Are there specific recommendations that could be directed to UL and SAE to synchronize their standards and also address the IOUs' interconnection concerns?
- Are there other standards or other approaches that could be considered to achieve compliance with smart inverter requirements?
  - It is not entirely clear at this moment that all automotive OEMs will utilize SAE J3072, so there should be consideration of alternative interconnection pathways. SAE is the most readily available and identifiable standard for certain V2G applications at the moment, but it should not be viewed as the only applicable standard.

In the longer-term future, the sub-group may wish to consider the interconnection review process for V2G systems that are co-located with distributed solar and/or BTM energy storage systems. The parallels to paired energy storage systems may be helpful here. For energy storage systems looking to be paired with rooftop solar on the NEM tariff, there are clear provisions in place to govern the interconnection of the combined resource, which is aided by how energy storage is defined as an "addition or enhancement" of the NEM-eligible generation,[22] rather than as two separate but co-located resources. For NEM-paired storage (NEM-PS) systems, the energy storage device has specific charging limitations, sizing limitations,[23] and metering requirements[24] to ensure NEM integrity. For non-NEM systems, how solar-plus-storage systems are reviewed under Rule 21 are less clear, though CESA believes that such systems not interconnecting under the NEM

[22] According to the RPS Guidebook, there are two such categories of energy storage: (1) Integrated storage are storage devices that are only capable of storing energy from the eligible renewable generator; and (2) Directly connected storage are storage devices that are directly connected to the eligible renewable generator via an internal power line.

[23] D.14-05-033 placed some limitations on the size of energy storage systems paired with NEM-eligible generators: All NEM-PS systems with storage devices 10 kW or smaller are not required to be sized to the customer demand or NEM generator. NEM-PS systems with storage devices larger than 10 kW will be required to have a maximum output power no larger than 150% of the NEM generator's maximum output capacity. For NEM-PS systems with storage devices larger than 10 kW, the discharge capacity of the storage system shall not exceed the NEM generator's maximum capacity and the maximum energy discharged by the storage device shall not exceed 12.5 hours of storage per kW.

[24] D.14-05-033 established self-contained, single-phase metering requirements: "Large" systems (paired storage device > 10 kW-AC) are required to comply with metering requirements similar to those in the NEM Multiple Tariff (MT) Special Condition by installing a non-export relay or interval meters. "Small" systems, (paired storage device 10 kW-AC) can use an estimation methodology to validate the eligible NEM credits. Fees associated with this metering requirement are limited to $600 (exceptions apply for complex metering arrangements). Interconnection costs that the NEM generator would be required to pay would apply for the storage applicant pursuant to Rule 21.

tariff to be rare at this time. Similarly, consideration in this working group should be given to how existing NEM or Rule 21 interconnection processes could allow for V2G systems to be accommodated. A performance-based approach may support such hybrid resource configurations during the interconnection review process.

4. **Clarify a pathway for parties to interconnect V2G AC systems on a timely basis for experimental and/or temporary use until the appropriate rules are updated in the future, consistent with any recommendations resulting from R.18-12-006, the VGI Roadmap, or other transportation electrification proceedings**

   As the CPUC, IOUs, and stakeholders work through V2G AC interconnection issues, CESA recommends that a path for some timely interconnection and deployment of V2G AC systems for pilots and/or temporary use be allowed. R.18-02-006, the newly opened proceeding, may direct pilots for V2G systems that would face barriers to operate and learn if interconnection stands as a barrier. In these limited instances, the IOUs should clarify a path for some temporary allowance for pilots and experimentation and not hinder pilot deployments due to interconnection issues, which may have *de minimis* impacts and are necessary to generate lessons learned for full deployment and achievement of VGI policy objectives. The details of the interconnection study process can continue to be developed in the meantime.

   CESA also raises the possibility for the CPUC to temporarily exempt V2G systems from meeting UL 1741-SA or any other smart inverter requirements at this time while being supplemented by SAE J3072 certification, which deals with some of the required functionalities under UL 1741. Within a certain cap of deployments, the CPUC could allow for the interconnection and deployment of V2G systems without requiring compliance with UL 1741, providing some time for V2G systems to be commercially deployed and for stakeholders to modify the applicable standards, while containing the magnitude of any grid impacts. Currently, there are no non-pilot deployments of V2G systems on California's distribution grid, and nearly all have been pursued under either direct sponsorship or oversight by regulatory agencies including the CPUC and CEC. By many degrees of magnitude, any concerns about frequency, voltage, or other distribution grid stability issues are relatively less for V2G systems than they are for rooftop solar systems or other generating facilities. Thus, a temporary exemption from Rule 21 smart inverter requirements appears to be worthy of consideration at this time while being supplemented by SAE J3072 certification. At the same time, CESA recognizes the importance of smart inverter requirements and prefers to work toward long-term sustainable solutions where smart inverter requirements can be appropriately applied to V2G AC interconnections.

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Appendix A: SAE J3072

SAE J3072 has defined the requirements for the information that must be shared between the EVSE and EV onboard inverter system for discharging at the EVSE site and for the EVSE to authorize the onboard inverter to discharge, thus allowing the EVSE and EV to operate as a single integrated DER. The EV inverter will interact with the facility, utility, or aggregator energy management system (EMS) to perform its operations and will set the value of its reference voltage to that of the EVSE so that the EV will not discharge when outside of the allowable or normal range, per IEEE 1547. Default settings for voltage range, frequency, and clearing time are referenced to IEEE 1547a Tables 1 and 2.

Table 4 - IEEE 1547 clarification and modifications

Paragraph	Comment
4.1.1 Voltage regulation	Only a PEV with a four quadrant converter shall permitted to actively participate to regulate the voltage by changing real and reactive power and only when authorized by the EVSE.
4.1.7 Isolation device	This requirement shall be achieved by uncoupling the PEV from the EVSE. A Lockout tag could be attached to the EVSE cord during an emergency or during maintenance as required by by facility safety practices.
4.2.3 Voltage	Voltage shall be measured at the output side of the inverter system power conversion unit. The inverter system shall use the default values defined in Amendment 1 for certification testing to this standard.
4.2.4 Frequency	The inverter system shall use the default values defined in Amendment 1 for certification to this standard.
4.2.6 Reconnection to Area EPS	The delay applies to discharging. The PEV shall use a fixed delay of five minutes.
5.3 Interconnection installation	Not applicable to roaming PEV
5.4 Commissioning tests	Not applicable to roaming PEV
5.5 Periodic interconnection tests	Not applicable to roaming PEV

It is important to highlight that SAE J3072 is the mechanism by which the inverter "system" is certified and is structured in a way to provide EV manufacturers with a standard that is flexible and non-prescriptive. For each of the functions above, there are no 'panels' or specific and standalone inverter hardware that constitutes the inverter (as in the case of PV inverters) but rather a combination of hardware and software integrations that constitute the inverter system. SAE J3072 was designed in such a way because every EV manufacturer configures its management system differently to provide this inverter functionality – *e.g.*, some use traction motors, others use electronic switches, others use auto loops – and does not 'put it all in a box' (*i.e.*, such that an exact inverter system, model number, etc. can be certified). The flexibility provided through the J3072 standard makes it workable for automobile OEMs and allows for innovation, but it also presents challenges for interconnection by utility engineers. However, as the CPUC evolves to consider inverter or non-export *functions* provided by software and firmware as opposed to strict hardware (*e.g.*, relays), utility engineers should be able to consider interconnection review of SAE J3072 certified inverters.

There are still gaps that may need to be addressed before SAE J3072 is adopted as the applicable standard for mobile inverters. For example, for the reasons stated above on how inverters are integrated as functions within the EV rather than as specific hardware, there may be concerns with EVs that are repaired and maintained by the dealer that could put the EV out of configuration and non-compliant with certified inverter functions. For every software update, there may need to be a discussion to determine whether re-certification is needed. However, CESA believes much of this interconnection compliance can be handled within the EVSE as the gatekeeper.